Strong flows of dilute suspensions of microstructure

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We consider dilute suspensions that have a microstructure that may be characterized by an axial state vector. Examples include axisymmetric particles, line elements of the fluid itself, or, as an approximation, droplets of fluid or polymer molecules. Past studies, in which sufficient conditions for stretch or coherent orientation of the microstructure are obtained for *steady* flows with *homogeneous* velocity gradient tensors are shown not to apply to the general situation. Instead, a careful analysis of the microdynamical equations reveals that stretching and orientation of the microstructure by the flow must be analyzed over a *time interval.* Using techniques from the theory of dynamical systems, a quantitative measure is developed to determine orientations and/or stretched lengths of the microstructure, that are robust and attractive to nearby states. This leads to a *strong flow criterion* for unsteady flows with inhomogeneous velocity gradient tensors in which the effects of history dependence are apparent. A particular model system is treated in the case of general two-dimensional flow. The sensitivity of the results to changes in the modeling assumptions is investigated.

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